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Conductometric Titration of Nickel (II) and Cobalt (II) Ions with 8-Hydroxyquinoline-5-sulphonic Acid*

Tetsuhei Tachikawa

Synopsis

Conductometric titration of nickel (II) and cobalt (II) ions with 8-hydroxyquinoline-5-sulphonic acid (H_2QS) was performed in the absence and presence of an excess amount of zephiramine (ZCl, tetradecyl-dimethyl-benzylammonium chloride) at pH 4~8.

The molar ratio of both cations to H_2QS was 1:2 at pH 4~8. On the other hand, in the presence of ZCl, this ratio was 1:3.

Introduction

The preparation, physical and chemical properties, and analytical application of 8-hydroxyquinoline-5-sulphonic acid (H_2QS) are described in the famous book by Hollingshead[1]. Recently, Bishop discussed the use of H_2QS as a complexing agent[2~5].

The present work shows that conductometric titration of nickel and cobalt ions with H_2QS can be carried out in the range of pH 4~8 and in the absence and presence of an excess ZCl.

Experimental

Apparatus Conductance measurements were made by means of an Yanagimoto Conductivity Outfit Model MY-7. A conductivity cell having two platinized platinum electrodes, 20 mm apart, and a cell constant of $0.47\,cm^{-1}$, was used.

Reagents 0.001 M and 0.01 M standard nickel (II) and cobalt (II) solutions were prepared from reagent grade nickel nitrate and cobalt nitrate, respectively. The metal ion solutions were standardized against the standard EDTA solution with Murexide as the indicator. H_2QS solution was prepared by dissolving a weighed amount of H_2QS (Wako Pure Chemical Industries Ltd.) in 1 liter of deionized water. In the case of preparation of 0.01 M solution, because of the poor solubility, 2.252 g of this reagent was dissolved in 1 liter of 1% sodium hydroxide. Buffer solutions of pH 4, 5 and 6 were prepared by mixing the proper amounts of 0.2 M potassium biphthalate and 0.2 M sodium hydroxide. Buffer solutions of pH 7, 7.6 and 8 were similarly prepared from the adequate amounts of 0.2 M potassium dihydrogen phosphate and 0.2 M sodium hydroxide.

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* Part of the dissertation presented by Tetsuhei Tachikawa to Hokkaido University, 1970.

0.01 M ZCl solution was prepared by dissolving 3.6805 g of Dotite Zephiramine (Dojindo Co.) in 1 liter of deionized water.

Results and Discussion

Fig. 1 shows the conductometric titration curves of the 20 m*l* solution containing cobalt ion in 2.5×10^{-4} M with 0.001 M H_2QS at pH 7, 7.6 and 8, respectively.

These curves consist of two straight lines. 'Rounding' in the vicinity of the intersection may be attributed to the partial dissociation of the produced complex. The fact that the conductance decreases in the course of the titration may be caused by the decrease in hydroxyl ion concentration due to the following reaction at pH about 8.

$$Co^{2+}+2H_2QS+4OH^- \longrightarrow Co(QS)_2^{2-}+4H_2O$$

After the knick point, the conductance decreases more slowly and the titration reaction is considered as given by

$$H_2QS+2OH^- \longrightarrow 2HQS^- +H_2O$$

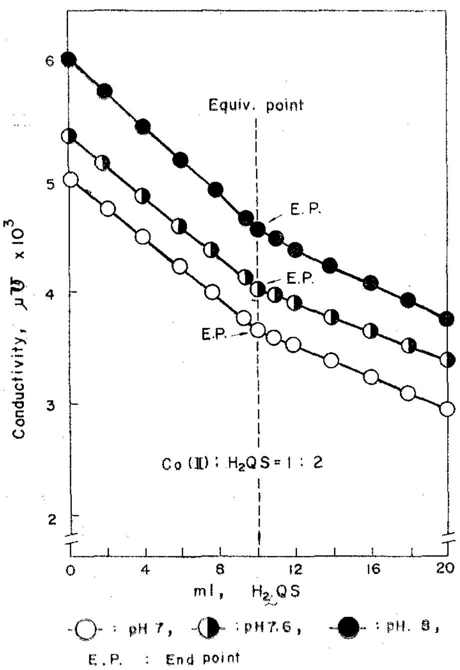

Fig. 1. Conductometric titration curves of the 20 m*l* solution containing cobalt (II) ion in 2.5×10^{-4} M with 0.001 M H_2QS aq. at pH 7, 7.6 and 8.

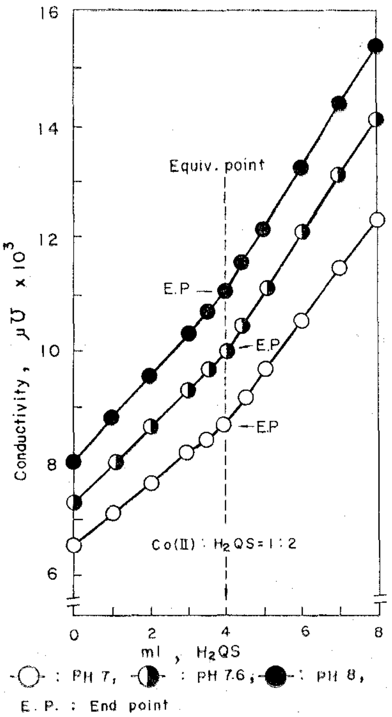

Fig. 2. Conductometric titration curves of the 20 m*l* solution containing cobalt (II) ion in 1×10^{-3} M with 0.01 M H_2QS in aqueous 1% NaOH solution at pH 7, 7.6 and 8.

The conductometric titration curves of the 20 ml solution containing cobalt ion in 1×10^{-3} M with 0.01 M H_2QS at pH 7, 7.6 and 8 are shown in Fig. 2.

The conductance increases as the titration proceeds. This is due to the addition of hydroxyl ion of high mobility contained in the titrant.

Figs. 1 and 2 indicate that there is a clear intersection of two straight lines at the point where the molar ratio of cobalt (II) to H_2QS is 1 : 2. Also in the titration of nickel solution with H_2QS, the similar result was obtained.

Fig. 3 shows the titration curves of a 20 ml portion of 1×10^{-3} M solution with 0.01 M H_2QS in the presence of excess ZCl (pH 6.2).

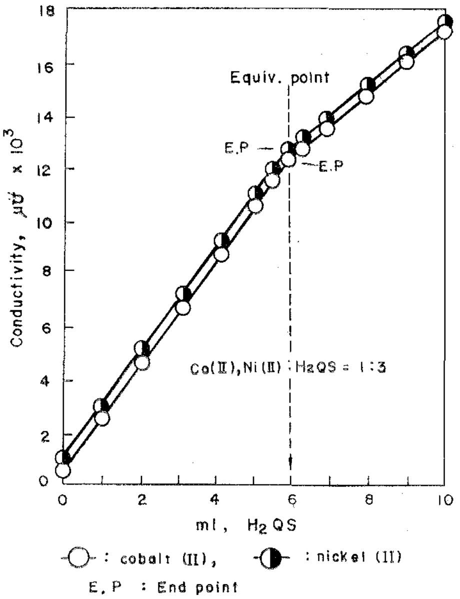

Fig. 3. Conductometric titration curves of 20 ml of 1×10^{-3} M solution of nickel (II) and cobalt (II) ions with 0.01 M H_2QS in aqueous 1% NaOH solution in the presence of zephiramine.

From Fig. 3, it can be recognized that at the intersection of two lines the molar ratio of the cations to H_2QS is 1 : 3. Kambara et al.[6] have studied spectrophotometrically the solvent extraction of the ternary complex composed of nickel (II), H_2QS and ZCl. They concluded that the composition of ternary complex is $Ni^{2+}(QS^{2-})(HQS^{-})(Z^{+})_3$.

It was found that 2.5×10^{-4} M to 1×10^{-3} M nickel (II) and cobalt (II) solutions can be titrated conductometrically with H_2QS at pH 4 to 8 in the presence of ZCl.

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